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MEMORANDUM

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DATE: March 24, 2008

SUBJECT: Review of CH2MHill, January 2008 Remedial Investigation Report, Omega Chemical Superfund Site, Operable Unit 2- Montebello Forebay, Omega Chemical Superfund Site, Whittier, California, 90602

PCA: 14125 Site Code: 300223-62 Log # xxxxx

Introduction:

At your request, the Glendale Geological Services Unit (GSU) prepared this memorandum to document our review of the Remedial Investigation (RI) Report described above. The objective of the RI is to determine the nature and extent of contamination in the aquifer to support the data needs for risk assessment, feasibility study, remedial design, public health assessment, and impact to natural resources.

Background

The Omega Chemical Superfund Site consists of two operable units. Operable Unit 1 is located at 12504/12512 East Whittier Boulevard, and covers just under one acre of land. It contains two buildings and is paved. It was first developed in 1951 by a bullet manufacturer, Sierra Bullets, and operated until 1963. From 1976 to 1991, the site was operated by Omega Chemical as a treatment and disposal facility for liquid waste, and a transfer station for consolidation and shipping of waste. Since 2003, an auto body shop and warehousing has occupied the property. Wastes that were handled by Omega included organic solvents, some mixed with water, from a variety of processes including petroleum refining, rubber and plastics, papermaking, furniture finishing, lumber and wood treatment, and food processing. COCs detected at the site include PCE, TCE, 1,1,1-TCA, 1,1-DCE, 1,4-dioxane, Freon 11, Freon 113, chloroform, methylene chloride, benzene, and acetone.

Operable Unit 2 consists of the downgradient extent of affected groundwater, and extends about 4.5 miles south-southwest of the Omega property. It mainly includes a developed industrial area overlying groundwater aquifers tributary to the San Gabriel River. During the Superfund investigation, several additional sources of contaminants were identified in the region.

Specific Comments

1) **Geology and hydrogeology**.

- The report states that the Gaspur aquifer is present beneath the site, but the boring logs do not support this conclusion. The Gaspur aquifer locally consists of Recent deposits of the San Gabriel/Rio Hondo system, and is characterized by a basal unit of cobble-to-boulder river channel deposits. Materials matching descriptions of this unit are not found in boring logs beneath the site. Bulletin 104's description of the Santa Fe Springs Plain seems more apt. The alluvial fans just east of the site show obvious evidence of structural warping and abandoned terraces consistent with continuing uplift and tilting along the Repetto Hills. One example is capture of a portion of the Worsham Canyon alluvial fan by the Turnbull Canyon fan, with subsequent rebuilding the the Worsham fan southeast of its former course. The broad regional descriptions in Bulletin 104 need to be re-referenced with respect to local geomorphic features.

- Section P-P' and Plate 7 of Bulletin 104 show that the site is actually on a physiographic terrace about ten feet above the main deposits of the San Gabriel River. The site is not on the river's current floodplain, and it is not clear whether flooding by the river was involved in cutting Sorensen Drain. The Gaspur aquifer is defined as San Gabriel/Los Angeles River channel deposits, which are typically very coarse-grained with boulders being present as far as south Downey. These deposits are not present under the site, nor are they shown as present in Bulletin 104. This distinction is important, because, in the absence of large pumping effects, the depositional direction of the sediment largely controls contaminant migration pathways. The topographic map shows that the site is mainly on a physiographic alluvial fan, which is composed of a complex overlapping of fans originating in Turnbull and Worsham canyons, and extending around the Santa Fe Springs Anticline out towards the coastal plain. There is no San Pedro formation beneath the site according to Bulletin 104.

- Section 4.5.1.4. The groundwater flow discussion is incomplete. Groundwater in the channel deposits of the San Gabriel River flow generally down channel, but groundwater within the alluvial fans originating in the Puente Hills flows down the depositional axes of the fan deposits. This can be demonstrated by drawing the plume to scale on the topo map. The plume flows at right angles to the contours, directly beneath and parallel to the surface expression of the Turnbull/Worsham fan. Downgradient of the site, the fans merge into the Gaspur, and the plume direction changes to become parallel with the River, although it does not merge into the River.

- Further support to the idea that these are alluvial fans is the observation that the groundwater gradient flattens just above the approximate location of the topographic transition from the midfan segment to the distal fan segment, which is where permeability normally drops an order of magnitude. The curvature in the groundwater contours by Los Nietos Rd may be related to water coming down the Worsham fan.

- Section 4.5.2.3 Lithology The materials beneath the site are not consistent with the clean, coarse deposits of the San Gabriel River. They are thin, discontinuous, and mainly fine-grained, with only occasional gravels. It is significant that the only boring log including the word 'cobble' occurs near the apex of the fan, and sediments become finer, not coarser, downhill of this well. This is not what would be expected of deposition by the San Gabriel River, even allowing for deformation.

- Section 4.5.2.5 Another plausible interpretation of the stratigraphic data is that the site is underlain by Lakewood-equivalent alluvial fan deposits originating in the Repetto Hills from specific, geographically restricted fans.. The apparent stacking of sediments, the many discontiunuites perpendicular to the fan (see Section B-B') and the fewer longitudinal discontinuities are explained as a natural consequence of typical alluvial fan sedimentation. There is obvious topographic evidence of continuing deformation of the fans during the later Pleistocene and Holocene. However, it is clear that the fans have continued to maintain their integrity despite deformation.

- Section 4.5.2.6 Conceptual Hydrogeology. The actual site hydrogeology does not match the regional hydrogeology as presented in the preceding sections. The principal difference is in the assumed direction of the depositional axis of the sediment. There are two possibilities: if the entire thickness of sediments originated as fluvial deposits of the San Gabriel River, a north-south section, parallel to the river, would show more continuity of deposits than the with the transverse section, which would show the ends of channels and poor horizontal correlations. If the sediments were deposited by alluvial fans, they would show an east-west longitudinal continuity pattern, with poorer continuity along north-transverse sections. The cross sections favor the alluvial fan interpretation. Sections A-A' and C-C' could readily be reinterpreted as longitudinal sections along a fan, with an upper and lower zone, in continuity near the apex of the fan, which is also the locus of recharge to the deeper zones, and Section B-B' appears more typical of a transverse section of a fan. The idea that this is a simple alluvial fan sequence makes it easier to understand how contamination reached the deeper zone, specifically, because near the apex of a fan, there is vertical continuity between the upper and lower sediments. The report's interpretation must invoke some other type of connection between the upper and lower zones to produce the observed pattern of contamination, yet is silent on how the vertical contamination occurred.

- Vertical gradients are not discussed in this section, but there are some very troubling trends. At MW-25 A-B-C-D, there is a downward gradient that directly conflicts with the interpretation that the anticline forces water to move upward over its crest. Instead, there is a very strong downward gradient, and no obvious way to prevent downward migration of the water in the lowest zone of MW-23. In fact, it is not clear at all where the water in MW23-C goes next, because MW-25D is not directly structurally downgradient of MW-23C. Contouring head on the cross sections might suggest some interesting flow patterns that have not been addressed in the RI.

- Section 4.5.3 Aquifer Properties GSU disagrees with the practice of separating out the more conductive zones of the aquifer, and assigning hydraulic conductivity to just that zone. This practice will tend to vastly underestimate the practical transmissivity of the aquifer, and lead to overestimating hydraulic parameters during modeling. Aquifers act as a unit, and dewatering a thin zone of high conductivity may also involve dewatering, by leakance, a much thicker zone of lower conductivity. A more conservative practice would be to calculate a geometric average of the Ks of the entire aquifer thickness. A unit that appears as a barrier during a short-term test may be a significant source of flow over tens of years. Lateral facies changes produce horizontal anisotropy, with its principal axis parallel with deposition, and its minor axis perpendicular to the axis of depositon. This effect, if not sought during aquifer tests, mimics leakance, and leads to overestimating K. The net effect is that the method described is likely to overestimate K, and underestimate downgradient capture radii.

- Figure 4-7,Section B-B' shows that the plume is staying centered in the section, without any tendency to slide west, down section, as if it were being held there by a permeability contrast. This suggests that B-B' is actually a cross section of a fan, and the plume is embedded in coarse material along its axis, and is kept there by low-permeability deposits in the interfan low-energy zones. It also suggests that the lower plume shown in C-C' on Fig. 4-7 is not hydrodynamically trapped against the anticline, (which would produce an upward gradient at MW-25-C) but is in a deeper part of the alluvial fan, and may be migrating downwards, based on the downward gradient. The idea that the anticline controls groundwater flow is not supported by the head data.

2) Cross Sections. The cross section numbers need to be added to the index map. The orientation of the sections makes it particularly difficult to determine the orientation of B-B'.

3) Bubble map. The concentration ratios should have been molar concentrations, not weight, since all the compounds have different molecular weights. Comparing weights distorts the relationships among compounds that have degradation products, since all degradation products are lighter than the parent compounds. Groundwater contours should be added to the map.

4) Groundwater model.

- The model used was based on a previous model by the USGS. Any user of the model inherits its assumptions and flaws as well as its strengths. It is particularly important to make sure the old model's depiction of boundaries does not unintentionally conflict with the needs of the new model. Boundaries are generally set away from the area of interest of the model, and there is often less care and attention to the fine details, because small errors at the edges will usually not propagate into the deep interior of the model. But for a site of interest near the perimeter, these simplifications may have large, sometimes adverse, effects. The user of the model is responsible for fixing these problems. It is not sufficient to assume that a model designed and accepted for another purpose will likewise be suitable for other purposes.

- The model was calibrated to heads, not flows. The previous flows were accepted without question. While models can generally calibrate to heads within acceptable levels, such solutions are non-unique and depend heavily on the accuracy of the water balance to generate flows, which then are distributed by the conductance fields. In the case of this model, heads are the most accurately known parameter, and flows are one of the most uncertain, yet without knowing flows, there is no way to know what K-field is correct, since an infinite number of Ks will calibrate to the same set of heads. Calibration to heads will not ensure that the model accurately matches the flow system. Some effort must be made to also calibrate to flows in order to reduce uncertainty.

- The calibration figures show that there is considerable scatter in the calculated heads for the regional wells. While the mean error was within 10 percent, the standard deviation was notably high. It is likely that this is because of poor boundary flow conceptualization, specifically, the use of constant head nodes along the River which is not fully penetrating and constantly saturated. Tabulation of the model water budget by zone and boundary type would be very useful to assess the proportion of model flows. In general, subsurface inflow and outflow ought not exceed areal reacharge, and certainly not by orders of magnitude.

- Areal recharge. Areal recharge is generally a very sensitive parameter, yet areal recharge was simply scaled and clipped for the model. There is known nonlinearity between rainfall and groundwater recharge, with practically no recharge when rainfall is less than 12"/yr, and nearly 30% when rainfall is greater than 20"/year. While the USGS capping of recharge at 1.3 inches (10% of an average year's rain) may be appropriate in some instances, there is no justification for this assumption at this area, and in fact this appears to underestimate recharge for wet years. The topo map also shows locations where there may be more or less surface recharge, and these could be easily incorporated into the model.

- In the case of this model, there are problems with the location and magnitude of recharge and the flow at boundaries. In the Omega area, Turnbull Canyon and other canyons are point inflow sources, as shown on the groundwater contour maps. The problem with assigning uniform mountain-front recharge is that it automatically introduces uncertainty in Ks, because it will certainly be too high in some places and too low in others. Inspection of the USGS topo map shows several specific places at canyon mouths where recharge may be adjusted, which will reduce uncertainty in K.

- Another problem with recharge is how to handle the central basin pressure area recharge. The pressure area is, by definition, confined, so areal recharge does not affect the water balance much in this area. Further justification of recharge in the pressure area is needed.

- Boundary conditions. The specified-head boundary along the San Gabriel River, northeast, and southeast boundaries are likely to greatly overestimate boundary flux. The San Gabriel River is not fully penetrating, and resembles more a head-dependent flux boundary than a constant-head boundary. The other boundaries do not communicate with bodies of water at all, and specified head is inappropriate for them. A water balance for the model boundaries is likely to indicate that unnaturally high conductances are needed to handle all the water that specified-head boundaries transmit. Most, if not all, boundaries should be changed to specified-flux.

- Specific yield. Rollin Eckis studied of specific yield in Los Angeles Basin soils, and found that most soils with more than one sieve size of particle tended to have specific yields in the 10% range, with very few clean coarse sands in the 25% range. (Calif. Div. Water Resources Bull 45, p 91-246, 1934). For the most part, outside of the Montebello Forebay, the local alluvial soils are mixed sizes, somewhat decomposed, and are seldom clean enough to have specific yields greater than 15%. Figure K-12 shows many instances of mismatches to hydrographs that are likely a result of overestimation of specific yield. Decreasing storage/specific yield will increase the responsiveness of the aquifer to changes in flux. Specific yield is related to effective porosity, and similar considerations apply to both. The soils data obtained during the studies do not support a conclusion that the materials beneath the site can be represented by 'clean sand'.

- The mismatch in heads shown near Los Nietos Road, as mentioned above, could likely be fixed by increasing recharge coming down the Worsham fan.

- Contaminant transport. Alluvial fans in semiarid settings similar to the site generally include periodic flood deposits with charcoal from brushfires. It is likely that the materials beneath the site include substantial organic carbon in the form of charcoal, concentrated in layers. In addition, organic carbon in the form of hydrocarbons is known to be found at various places beneath the site. The VOCs of interest at the site are variably adsorbed to organic carbon, resulting in variable retardation of the rate of plume migration for the different compounds. Of the VOCs, 1,4-dioxane is affected the least, and PCE the least. If retardation is to be neglected in the analysis, then a compound such as 1,4-dioxane should be used instead of TCE or PCE for calculation of groundwater velocities and plume velocities. Naturally occurring organic carbon has not been adequately characterized beneath the site.

Conclusions and Recommendations:

1. The interpretation of the site stratigraphy is not supported by the plume geometry, especially its relation to topography, and by the vertical gradient data. The conceptual hydrogeologic model should be reevaluated. While a thin section of San Pedro formation may be present at depth beneath the upper part of the Unit 2 area, most of the section appears to consist of continental alluvial fan deposits which originate on and lap onto the Repetto Hills. While the alluvial

fan units are time-correlative with Gaspur-age deposits in Whittier Narrows, they are not the same facies, and do not have the same hydraulic properties.

2. The groundwater model relies heavily on an earlier model, and has questionable boundary conditions at its lower extent. As a result, there is considerable uncertainty in the results, which could be reduced by further constraining flows at the boundaries. Likewise, recharge has been applied with a broad brush, but there are obvious ways to refine recharge in the area near the site that might improve the model. A groundwater budget for the model that compares boundary inflows by category, pumpage, recharge, and outflow by category, is needed. Changing constant-head (CHB) boundaries to general head (GHB) boundaries would help limit water balance errors, which drive conductance errors. If recharge and discharge from constant-head nodes significantly exceeds areal recharge and mountain-front recharge, then these terms have likely been overestimated, and therefore hydraulic conductivity in the lower model area is overestimated.

3. Vertical gradients have not been addressed. The pattern of vertical head distribution suggests there may be data gaps in the lower part of the plume.

4. Quantitative velocities calculated by the model should not be relied on until additional work is done to calibrate flows.

Questions regarding this memo should be directed to Ms. Alice Campbell by contacting her at 818-717-6623 or acampbel@dtsc.ca.gov.